

## APPENDIX C

### RIVERS PROGRAM: PROGRAMMATIC ELEMENTS

#### ***INTRODUCTION***

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The Flood Hazard Reduction Program policy guidance adopted by King County Council on November 15, 1993 (see Appendix A), includes 45 individual policies that are divided among seven categories. These include 13 general policies; eight floodplain land use policies; four watershed management policies; 13 flood hazard reduction project policies; three river channel maintenance policies; two flood warning, information, and education policies; and two emergency response policies. To meet the goals and objectives of these new policies, the present River Management Program was established and the following Program components or elements were identified:

- Structural Capital Improvement Projects (levees, bank stabilization, and other structural flood control measures).
- Relocation and Elevation Projects (relocation, purchase and demolition, or elevation of flood-prone homes in floodplain areas).
- Maintenance and Monitoring (repair and maintenance of projects and channels, monitoring of channels and the effectiveness of structural flood control).
- River Planning (studies along major rivers to help in project selection and design and land use regulation).
- Flood Hazard Education (approaches to increase public and agency awareness of flood hazards, regulations, and programs).
- Flood Warning and Emergency Response (flood warnings, levee patrol, sandbag distribution, and emergency repairs).
- Complaint Response and Enforcement (response to complaints, claims and lawsuits, enforcement actions when necessary).
- Inter-local Coordination (agreements with other jurisdictions in the major river basins to promote consistency, cooperation, and technical assistance).

#### ***APPENDIX ORGANIZATION***

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The remainder of this Appendix presents an overview of each of the Program elements listed above. For increased clarity and easier discussion, several multi-purpose elements (e.g., maintenance and monitoring; complaint response and enforcement) have been divided into their separate components. For each individual Program element, the goals and supporting policies are first outlined. Next, examples of the types of construction and maintenance projects promoted under that element are identified. **Emphasis is deliberately placed on elements and projects that have the potential to either directly or indirectly affect threatened or endangered species and/or their associated habitats.** Current implementation of the particular Project element is briefly summarized and finally, any obvious potential regulatory conflicts or constraints to successful implementation of the element are noted.

## DESCRIPTION OF PROGRAM ELEMENTS

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### (1) STRUCTURAL CAPITAL IMPROVEMENT PROJECTS

#### 1.1 Program Element Goals

This element focuses on designing and building **new** Structural Capital Improvement Projects (CIPs) to reduce flood hazards along the major rivers in King County. These larger projects consist primarily of building new levees and improving existing levees (freeboard increases and set backs); bank stabilization projects, typically emphasizing biotechnical approaches; re-establishment of overbank conveyance channels; and road and bridge improvements to reduce flood damages to and around these structures. Smaller projects, often constructed in conjunction with these major projects, include culverts and floodgates, and channel modifications.

#### 1.2 FHRP Supporting Policy

The River Management Program's potential to construct **entirely new** flood protection facilities in King County reflects several of the FHRP General Policies. For example: Communities should not only meet, but exceed, federal minimum standards to qualify for protection under the National Flood Insurance Program (Policy G-1); and, Jurisdictions in King County should seek to reduce the risk of severe flood hazards and damages experienced by existing public and private developments (Policy G-4).

Flood Hazard Reduction Project policies provide a list of specific types of property and problems eligible for flood protection under King County's River Management Program (Policy FHR-1), procedures for determining the priority of a particular problem (Policies FHR-2, 3), and methods for evaluating and selecting the most appropriate solution from a group of project alternatives (Policy FHR-4). Wherever possible, projects are to be designed to minimize long term maintenance needs (Policies FHR-9, 11); to include preservation or creation of wetlands and fish habitat areas, as well as being compatible with open space and recreation opportunities (Policy FHR-8); and to provide for limited public access and related passive uses (Policy FHR-13).

Policy FHR-7 addresses 'level of protection,' recommending that all **new** flood hazard reduction projects, whether protecting new or existing development, should be built to provide protection from the 100-year, future conditions flood, plus a margin of safety. When new projects are built to protect existing development and 100-year protection is not practical, then lesser protection may be provided. Facilities protecting existing development should be maintained at their current level of protection.

FHRP policies carefully distinguish between maintenance of existing facilities and implementation of new structural CIPs. Any maintenance activity that, "...**significantly changes** the cross-section geometry or length of an existing flood- or erosion-control

facility...” is considered a new project (CIP), and is analyzed, prioritized and implemented as such. Projects that do not cause such changes are implemented as part of the maintenance program (Policy FHR-12). Maintenance typically involves repair of a facility to its pre-damage condition and is generally performed without detailed analysis or formal design.

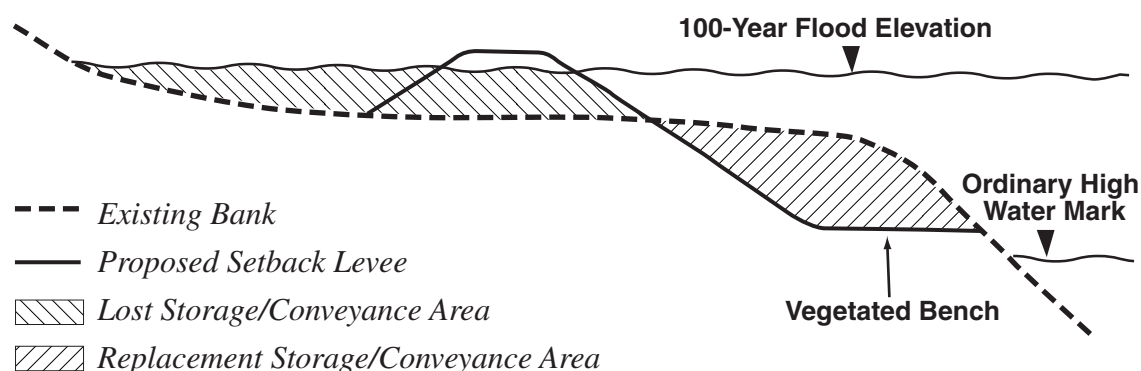
### 1.3 Project Examples and Activities

#### *New Levee Construction*

Where a new levee is proposed, or an existing levee raised, to contain the 100-year flood, flood storage and conveyance area behind the levee will be lost. To meet the compensatory storage and zero-rise requirements of the King County Sensitive Areas Ordinance (SAO) all new levees will employ a setback levee design (Figure 1). These levees are built further away from the river channel thereby providing additional overbank storage area and lower flood stages, which together will result in reduced stream velocities, lower downstream peak flows, and reduced maintenance. To reduce riparian habitat impacts, a “bench” excavated between the top of the riverbank and the levee would be planted with riparian vegetation. The FHRP notes that a significant problem with the setback levee design is the conflict between the excavation needed to meet the SAO floodplain requirement and another SAO requirement – that stream buffer habitats be fully protected. Compliance requires that the levee setback include the unaltered stream buffer in addition to sufficient width for excavation of storage and conveyance replacements. Exemptions from this buffer requirement are possible if the project includes velocity reductions, storage additions, and habitat improvements that qualify it as an enhancement of the sensitive area.

If the project consists solely of the levee and all activities take place above the riverbank (i.e., ordinary high water), then construction – typically involving heavy equipment and extensive earth-moving – could take place in the dry season, entirely out of the channel, during the summer months. More likely any new levee project would be combined with rock toe protection and biotechnical bank stabilization, which would involve significant in-channel construction activity.

**FIGURE 1**  
**Setback Levee**



Appendix B of the FHRP (1993) identifies 20 potential CIPs involving construction of **new** levees to reduce flood damages along a total of approximately 41,200 linear-feet of riverbank along King County's principal rivers. The total cost of these potential projects was estimated at \$45.3 million (1992 dollars).

### ***Freeboard Improvements to Existing Levees***

Figure 2, shows how the freeboard – distance between 100-year flood elevation and levee crest – of an existing levee can be increased without grading activity in the adjacent 100-year floodplain. The Federal Emergency Management Agency (FEMA) requires at least three feet of freeboard before qualifying an area as adequately protected from the 100-year flood for national flood insurance purposes (Policies G-1 and FHR-7). Freeboard increases would not affect 100-year floodplain conveyance or storage and are therefore not subject to the County's floodplain regulations.

Construction could take place in the dry season, entirely outside the channel, during the summer months.

### ***Set Back of Existing Levees***

Where existing levees have been placed along a river channel, significant opportunities to increase overbank conveyance and reduce flood stages can be gained by setting back the levees further from the channel (Figure 3). Since the setback design increases the available storage volume and capacity, it satisfies SAO flood hazard regulations. An exemption from SAO's riparian habitat requirement could again be gained by enhancing the excavated bench on the riverside of the levee with riparian plantings.

Levee set back construction could take place above the riverbank, entirely out of the low-flow channel, over the summer months. As noted above, however, new levee set backs would more likely be combined with instream rock toe protection and with biotechnical bank stabilization at the same site.

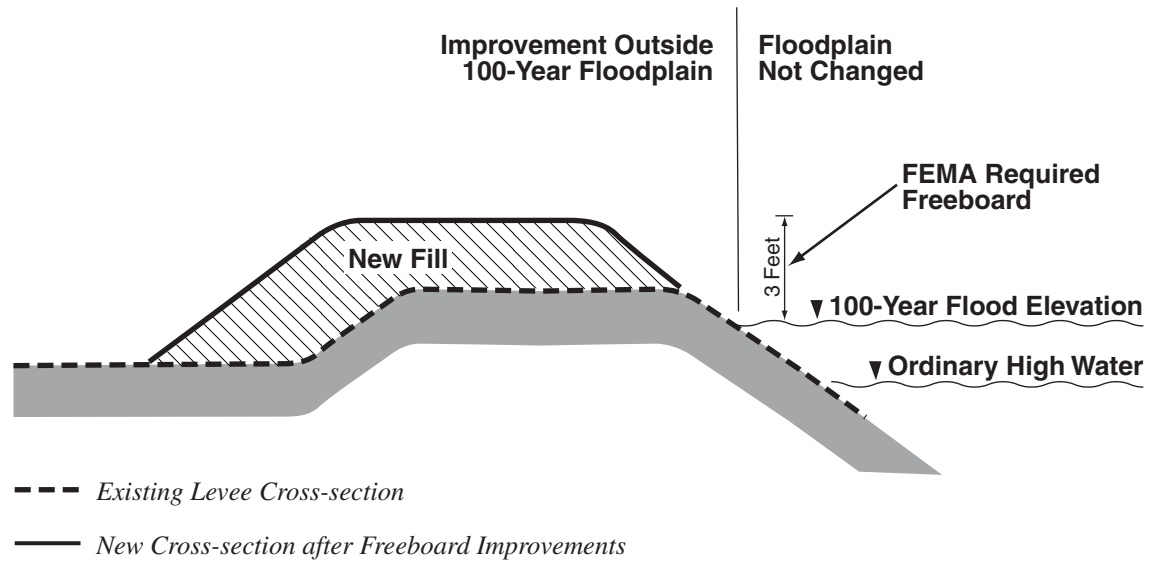
Appendix B of the FHRP (1993) identifies 14 potential CIPs that would **upgrade/retrofit existing levees** – to reduce flood damages – along another 107,522 linear-feet of riverbank. The total cost of these potential projects was estimated at \$50.5 million (1992 dollars).

### ***Biotechnical Bank Stabilization Projects***

Prior to adoption of the new FHRP and Guidelines for Bank Stabilization Projects in 1993, King County traditionally built rock revetments to protect stream banks from erosion. These facilities mostly consisted of rock riprap, end-dumped from trucks onto and down the riverbank, and shaped in place with dragline equipment. Following publication of the 1993 Guidelines, bank stabilization issues have usually been addressed using much less environmentally harmful biotechnical (soil biostabilization) methods. The preferred stabilization approach is now "brush layering," a proven technique that involves alternating layers of willow cuttings and soil, often installed above a rock toe (Figure 4). The rock toe (rock toe key) is installed underwater, at the base of the riverbank, to reduce the potential for river-current and flood-flow scour, undercutting, and collapse of the overlying brush layered slope.

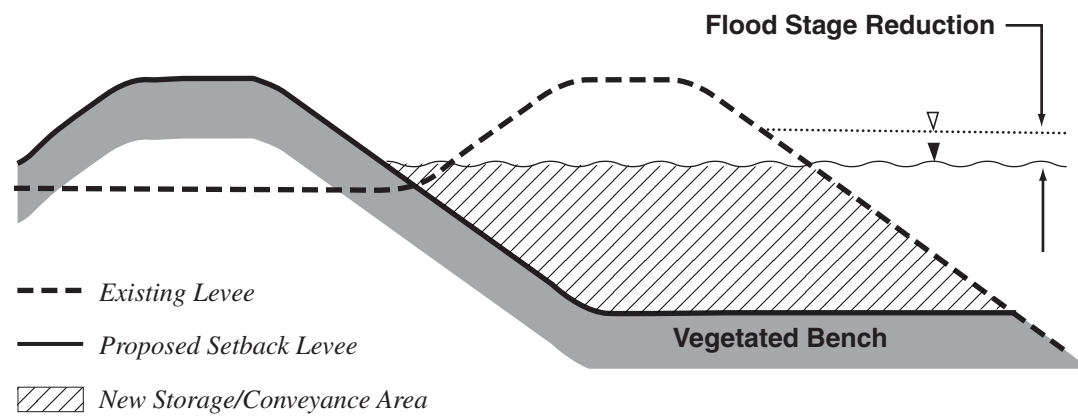
**FIGURE 2**

**Freeboard Improvements to an Existing Levee**

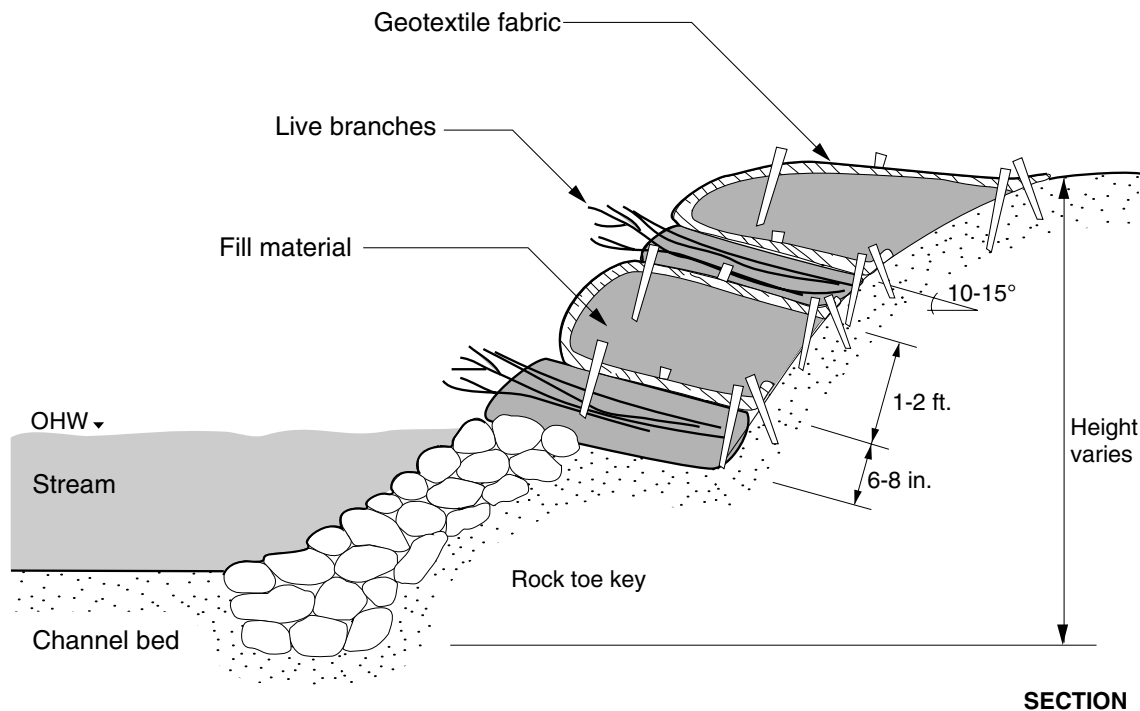


**FIGURE 3**

**Setting Back an Existing Levee**



**FIGURE 4**  
***Installation of a Vegetated Geogrid Shown with an Optional Rock Toe Key***



These projects grow stronger over time as the riparian vegetation becomes established and the plant roots bind the riverbank soils together. Since the dense, irregular, vegetation cover creates a rougher surface than rock/riprap revetments, they absorb more stream energy, lowering local flow velocities and erosive energies. The established vegetation also provides shade, contributes organic matter, and supports invertebrate prey organisms that can benefit fish habitat.

It should be noted that no new rock/riprap revetments have been installed by the Rivers Program since 1993. Riprap, however, is still sometimes used for repair of existing revetments.

Appendix B of the FHRP (1993) identifies 65 potential CIPs involving bank stabilization projects to reduce erosion damages along King County's major rivers. Sixty-one of these potential projects, lining 100,900 linear-feet of riverbank, would utilize the **biotechnical construction** methods described above, at a projected cost of \$64 million (1992 dollars). Four additional potential CIPs recommend installation of rock **riprap revetments** to stabilize 9,600 linear-feet of riverbank at specific locations, at an estimated total cost of \$4 million (1992 dollars).

### ***Overbank Conveyance Channels***

The FHRP notes that installation of levees and revetments has historically eliminated numerous river side-channels (also called overbank channels because they only convey flow during overbank flooding) by cutting them off from the main river channel. Overbank

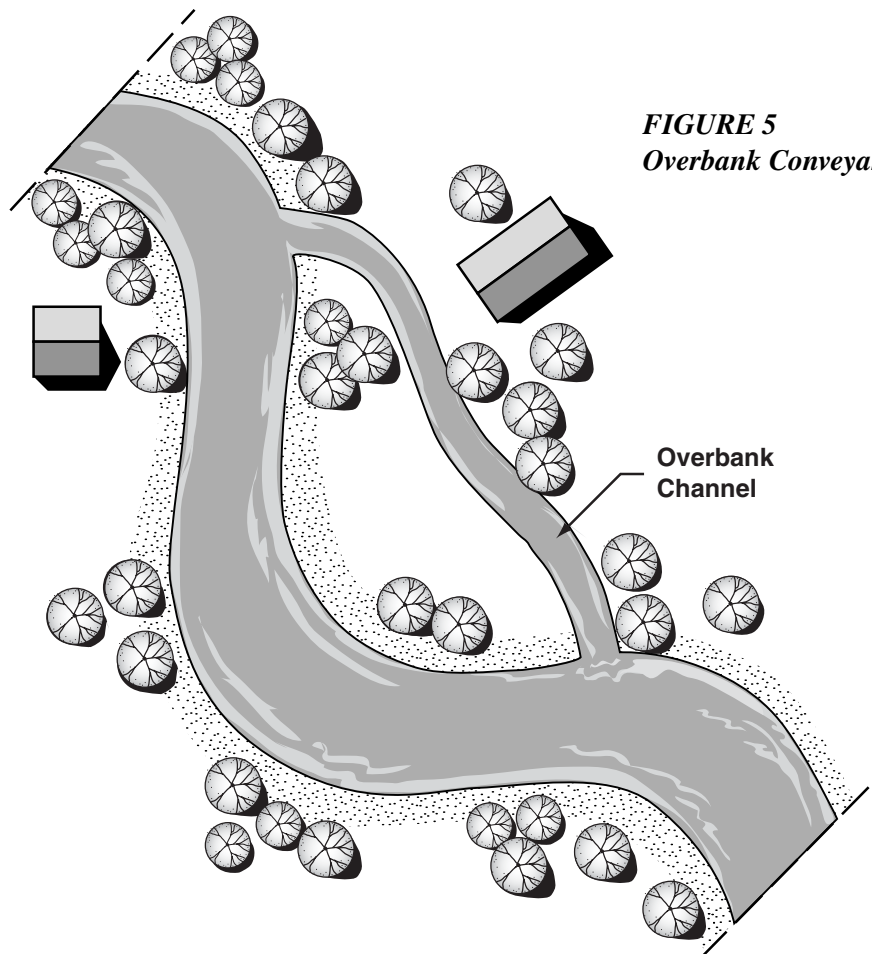
channels can accommodate substantially higher river flows without causing widespread flooding, and they provide important refuge and rearing habitat for salmonids. Re-establishing these channels offers an opportunity to increase local conveyance area, lower local flood elevations, and restore fish habitat.

Re-establishing overbank conveyance channels (Figure 5) would involve purchase of appropriate land parcels and removal or relocation of any structures within the old channels. This would also likely include the removal and/or relocation of any levees that might presently block the channel entrance (i.e., connection to the main river channel). If no longer in a natural state, the overbank channel may need to be regraded and replanted with appropriate native riparian vegetation.

Appendix B of the FHRP identifies 15 potential structural CIPs involving re-establishing a total of 42,910 linear-feet of overbank conveyance channels to reduce flood damages along King County rivers. The total cost of these potential projects was estimated at \$60 million (1992 dollars).

### ***Road and Bridge Improvements***

Many of the existing flood control facilities in King County were originally built to protect roads or bridges that sustained flood damage. Insights gained from the Thanksgiving Day 1990 Flood show that it can be substantially more cost effective to modify the design – or



**FIGURE 5**  
***Overbank Conveyance Channel***

even the location – of a particular bridge, bridge approach ramp, or section of roadway, than to pay the costs of frequent or severe repairs to some of these older facilities. Even when no flood control facility is present, flood damages to a particular bridge or road may justify its redesign or relocation. The location or spacing of bridge abutments and piers can exacerbate increased flood flow and channel scour problems, while a bridge with low flood clearance may increase the risk of log jams, flow diversions, or structural damages.

Appendix B of the FHRP identifies 33 potential structural CIPs involving potential **road and bridge improvements**. Together, these potential projects would redesign, repair, or reconstruct 46,200 linear-feet of flood-damaged roadway, and relocate another 69,500 linear-feet of existing flood-prone roadway. These estimated total cost of all 33 potential road and bridge projects was \$29 million (1992 dollars).

#### *Miscellaneous CIPs*

Miscellaneous structural CIPs include a wide variety of generally smaller potential projects that are typically constructed in conjunction with the much larger CIPs described above. Examples include: culverts, floodgates, and pumping stations – that allow local runoff to drain through a levee while preserving the levee’s flood containment abilities; and channel modification – possible excavation of river channel bedrock where no opportunities for installation of a sedimentation basin exist.

Appendix B of the FHRP identifies a variety of these miscellaneous CIPs associated with larger Rivers projects and estimates the total cost for implementation of all of them at \$12 million (in 1992 dollars).

### **1.4 Implementation**

King County has either built or sponsored numerous capital improvement projects for flood control along its major rivers. The majority of these structural CIPs, however, were built in the 1960s and 1970s. Indeed, prior to adoption of the FHRP, no new flood control CIPs had been built along the County’s rivers since the 1970s (FHRP 1993, p.10). River Management Program activities are now restricted to maintenance or modest upgrades of their inventory of some 476 existing facilities (King County 1990, Table 5).

The FHRP indicates that the major impediment to implementing new structural CIPs since the 1970s has been the very limited availability of funds. Had funding been available, the Rivers Management Program would presumably have continued to build new levees and bank stabilization projects – albeit using less environmentally damaging biotechnological methods – along the uncontrolled reaches of the County’s rivers. More recently, recommendations from additional studies, changing river conditions, and the new regulatory climate and legal requirements of ESA salmonid listings, have resulted in a need to seriously re-examine the 1993 Appendix B CIP recommendations for appropriateness and feasibility, and to develop alternative recommendations as appropriate.

### ***Annual Accomplishments***

As noted above, no **new** CIPs have been planned or constructed by the River Management Program to date – i.e., since 1993, no new levees or revetments have been installed along reaches of riverbank where no such structures had previously been present. While numerous levee and revetment flood-damage repairs, facility upgrades, and maintenance actions have been completed since 1993, River’s staff indicate that none have resulted in “significant changes” to either river channel cross-section geometry or facility length. Having done so would move them into the “new CIP” category (Policy FHR-12). All of these activities are therefore included under the Major Maintenance Program element, described below.

### ***Potential Conflicts***

Any new River’s Program structural CIP project would be subject to normal review and regulatory permit approval procedures from appropriate local, state, and federal agencies. These requirements are re-enforced through the 1991 Flood Bill (Engrossed Substitute Senate Bill, ESSB 5411) that requires coordination meetings between project proponents and appropriate local, county, and state regulatory agencies.

Potential conflicts regarding King County’s Sensitive Areas Ordinance (SAO) – particularly the potential conflict between the zero-rise floodplain excavation requirement and the requirement to leave riparian vegetation and protective buffers undisturbed, was noted above. The fact that an exemption can be approved if the proposed project results in overall habitat enhancement appears to offer appropriate flexibility and encourage innovative planning solutions.

Local conflicts have arisen between habitat restoration activities associated with riverbank projects – particularly the installation of large rocks and large woody debris – and public rights of navigation and use of the shoreline, under local and state Shoreline Permit guidelines. Some boating supporters regard such projects as increasing potential hazards to their safety.

The most serious potential conflicts involve federal design criteria that must be met if King County is to receive federal funding for flood damage repair work and flood facility upgrades. In several cases – mostly involving the re-establishment and protection of riverbank riparian vegetation – federal regulations either don’t allow, or won’t pay the costs of riparian plantings, especially trees. Examples include: Federal Flood Control Act (1948), Section 205 and Public Law 84-99, both administered by the U.S. Army Corps of Engineers (Corps); and Public Law 93-288, administered by the Federal Emergency Management Agency (FEMA). FEMA, for example, will only pay for riparian plantings as part of facility repairs or improvements if the plantings are required and enforced by adopted local standards. The bank stabilization guidelines have been accepted by FEMA as constituting such a “standard.” In contrast to these agencies’ disapproval of riparian plantings as an integral part of flood hazard reduction facilities, King County specifically encourages the use of less environmentally damaging biotechnical methods of bank stabilization that depend on riparian vegetation both for structural integrity and significant long-term benefits to fish habitat.

## **(2) RELOCATION AND ELEVATION PROJECTS**

### **2.1 Program Element Goals**

This program element implements the relocation and elevation of residential dwellings located in flood prone and erosion-hazard areas as a long-term cost-effective solution to repetitive flooding problems. It was a major new initiative in the 1993 FHRP, representing the first time that King County proposed relocation and elevation of structures as regular alternatives to traditional levees and revetments.

Acquisition and relocation accomplishes the following goals: provides a permanent solution to flood and erosion hazards; reduces public expenditures for flood insurance claim payments; creates additional flood storage and conveyance; and, can provide the added benefits of public river access and the restoration or preservation of wildlife habitat. Elevation projects reduce the threat of future damage; do not create new maintenance commitments; usually result in reduced federally-backed flood insurance claims; can lower property owner or resident insurance rates; and allow the resident to remain on the same property, thus maintaining existing housing stock.

### **2.2 FHRP Supporting Policy**

Relocation and elevation projects are supported under General Policy G-4: Jurisdictions in King County should seek to reduce the risk of severe flood hazards and damages experienced by existing public and private developments.

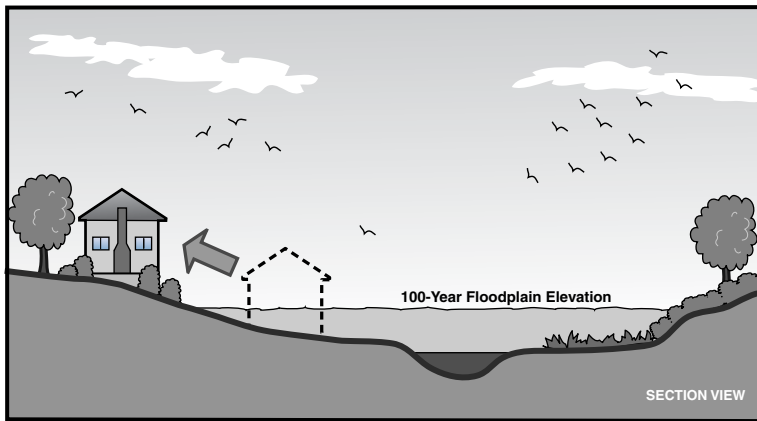
Flood Hazard Reduction Policies FHR-1,2, and 3, respectively, address the types of properties and problems eligible for protection, problem prioritization, and the alternatives evaluation and selection process. More specifically, Policy FHR-5 encourages County acquisition of flood-prone lands and threatened buildings only when there are willing sellers. Condemnation of land is reserved for very limited circumstances. Policy FHR-6 states that when flood-prone structures are acquired and relocated or demolished by the County, the vacant land thus created should either include an easement to the County, or be owned and managed by King County as open space, riparian corridor, agriculture, or a recreation site.

### **2.3 Project Examples and Activities**

#### ***Relocation Projects***

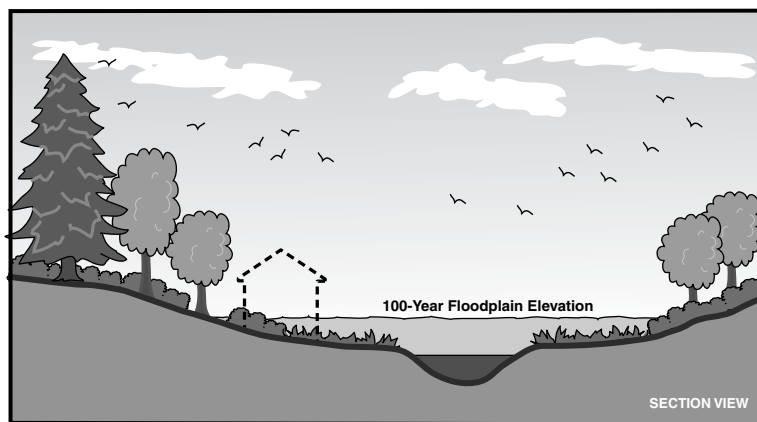
Acquisition and relocation can refer to either demolition of a flood-prone structure and relocation of its residents, or actual relocation of the structure (Figure 6). Relocation is recommended in very high flood hazard areas – those subject to repetitive, deep, high-velocity flood flows or undercutting due to channel migration. In these cases, a structural solution such as a levee or revetment may be physically infeasible and/or not cost effective.

**FIGURE 6**  
**Relocation and Elevation**



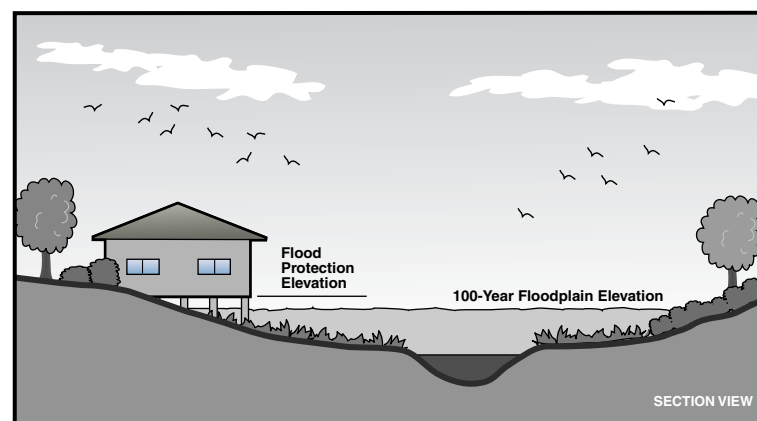
### **Relocate**

Move existing structure to another location out of the floodplain.



### **Purchase & Restore Floodplain**

Purchase property, demolish structure and restore site with native plantings.



### **Elevate**

Elevate house to one foot or more above 100-year flood elevation. Portions of a building that are below the lowest floor area shall not be fully enclosed and comply with FEMA and King County standards.

Relocation might involve preparing a mobile home for transport and moving it to a new location. Any necessary planning and permitting actions would have to be completed and approved in advance. Utility lines, foundation walls and pads, and access roads might need to be disconnected, demolished, and removed off-site to an approved disposal site. Comparable facilities would need to be installed at the new mobile home location.

Relocating or demolishing a house could be more involved. Planning, engineering, and permitting actions would need to be completed, and temporary erosion control protective measures put in place. Any sensitive habitats on-site would be cordoned-off for protection prior to any heavy equipment activity. Again, all utilities and infrastructure would be disconnected and removed, including any buried storage tanks, concrete foundations and footings. A house might be raised off its foundations and moved off-site, or demolished in place. All debris, possibly including hazardous materials such as chemicals, asbestos or fuel oil, would be carefully cleaned up and moved off-site to an approved disposal facility. Once a site had been cleared, seeding and plantings would likely be needed to minimize erosion. Ideally, all demolition activities would be accomplished during summer dry weather conditions.

Appendix B of the FHRP identifies numerous projects that together include 234 individual residential structures, for which acquisition and relocation would be the most cost effective approach to reduce future flood hazards. The total cost for all of these projects was estimated at \$42 million (in 1992 dollars). An additional 113 individual mobile home relocations, costing an estimated \$7 million (in 1992 dollars), were also recommended.

### ***Elevation Projects***

Home elevations involve raising the lowest habitable finished floor at least one foot above the 100-year base flood elevation (Figure 6). These projects are for protecting the property, not to provide a safe refuge from flooding. Elevations are targeted in locations where homes experience low velocity flooding; it is not a solution appropriate for homes threatened by bank erosion.

Though elevations are generally simpler and less expensive than home acquisition and relocation projects, they entail many of the same general activities. Appendix B of the FHRP identifies 168 flood-prone residential structures for which elevations would be cost-effective. The total cost for all of these projects was estimated at \$4 million (in 1992 dollars).

## **2.4 Implementation**

Despite the inherent benefits of relocation, federal and state funding for this approach is very limited. The majority of federal disaster assistance and flood insurance programs focus on returning damaged public infrastructure and private homes and businesses to their pre-flood condition, rather than on measures that would eliminate future damages.

Homes covered by flood insurance, with a history of repetitive flooding, are most likely to receive funding. Therefore buyouts are targeted for neighborhoods where there are a significant number of “FEMA Repetitive Loss” properties.

### ***Annual Accomplishments***

Despite funding difficulties, King County, between 1992 and March 2001, purchased and removed 27 flood-prone homes from local floodplains. Of these, 15 were FEMA repetitive loss properties.

Since 1996, King County has been awarded three FEMA-funded, Washington State grants to elevate repetitively damaged homes: one Hazard Mitigation Grant (HMG) to elevate 17 homes and two Flood Mitigation Assistance (FMA) grants to elevate ten homes. The HMG project was not completed because of homeowner reservations that the elevation project would not solve neighborhood-flooding problems. The two FMA grant projects were completed in 2000 and 2001.

### ***Potential Conflicts***

Ideally, relocation and elevation projects should occur during summer dry weather conditions when potential indirect impacts to adjacent river channel habitats would be minimal. Some federal funding sources, however, require that demolition and removal be entirely completed within 90 days of the funding award, irrespective of the time of year. This may result in conflicts with construction/activity windows required by state and federal agencies to protect threatened and endangered species and their habitat.

## **(3) MAJOR MAINTENANCE**

### **3.1 Program Element Goals**

King County River Management Program has 476 river facilities in its maintenance inventory (as of 7/12/1989; King County 1990). These facilities include mostly levees (90) and revetments (372), related access roads and gates, and a few pump plants, flap gates, and boat ramps. Some of these facilities, such as those on the White River, were originally constructed after the turn of the last century; most newer facilities were built in the 1960's and 1970's. The facilities range from extensive containment levee systems, such as along the Green River, to lengthy reveted reaches on the Cedar River, to sporadic facilities located in rural areas of the upper Snoqualmie River and the South Fork Skykomish River. The entire 13.8 miles of the Sammamish River is considered a single 'facility' because it is an engineered channel.

The FHRP describes maintenance recommendations under "Maintenance and Monitoring." The recommendations include improved techniques for the use of rock riprap, incorporation of vegetation into facility repairs, improved standards for vegetation management, and consideration of major retrofits including levee set backs. The Plan addresses the need to maintain a facility inventory and to revise annual assessment procedures. Procedures to evaluate potential dredging and logjam removal projects are also discussed.

This Program element addresses the goal of "major maintenance" at River's facility sites. While the FHRP does not specifically define major maintenance, it has come to include those projects that require mobilization of heavy equipment and extensive earth moving. Most such projects also include in-channel repair/construction activities and typically require extensive local/state/federal regulatory agency review and permitting.

### 3.2 FHRP Supporting Policy

General Policies G-6, 7, and 8, address the issues of reducing long-term public costs (i.e., emphasize low-maintenance solutions), protecting natural resources and functions of floodplains, wetlands, and riparian corridors (i.e., includes potential habitat enhancement or restoration), and multi-objective management of water resources, respectively. Flood Hazard Reduction Project Policies identify general procedures for determining problem/project eligibility (Policy FHR-1), problem prioritization (Policy FHR-2), and the evaluation of project alternatives (Policy FHR-3).

Two additional Flood Hazard Reduction Project Policies provide guidance that is more specifically directed at major maintenance-related issues. Policy FHR-9 states:

“King County should, wherever possible, design projects in ways that require minimal or no maintenance over the long term. Levees and bank stabilization projects should include, where possible, toe rock, setback areas, vegetated stream banks, gentle riverward slopes, and materials and placement methods that provide long-term stability to the interior and face of the project.”

Policy FHR-11 addresses the issue of on-going, long-term improvement of River’s facilities – i.e., reducing long-term maintenance needs, while increasing project stability and enhancing natural habitat functions – rather than automatically returning damaged facilities to their original design or as-built condition.

### 3.3 Project Examples and Activities

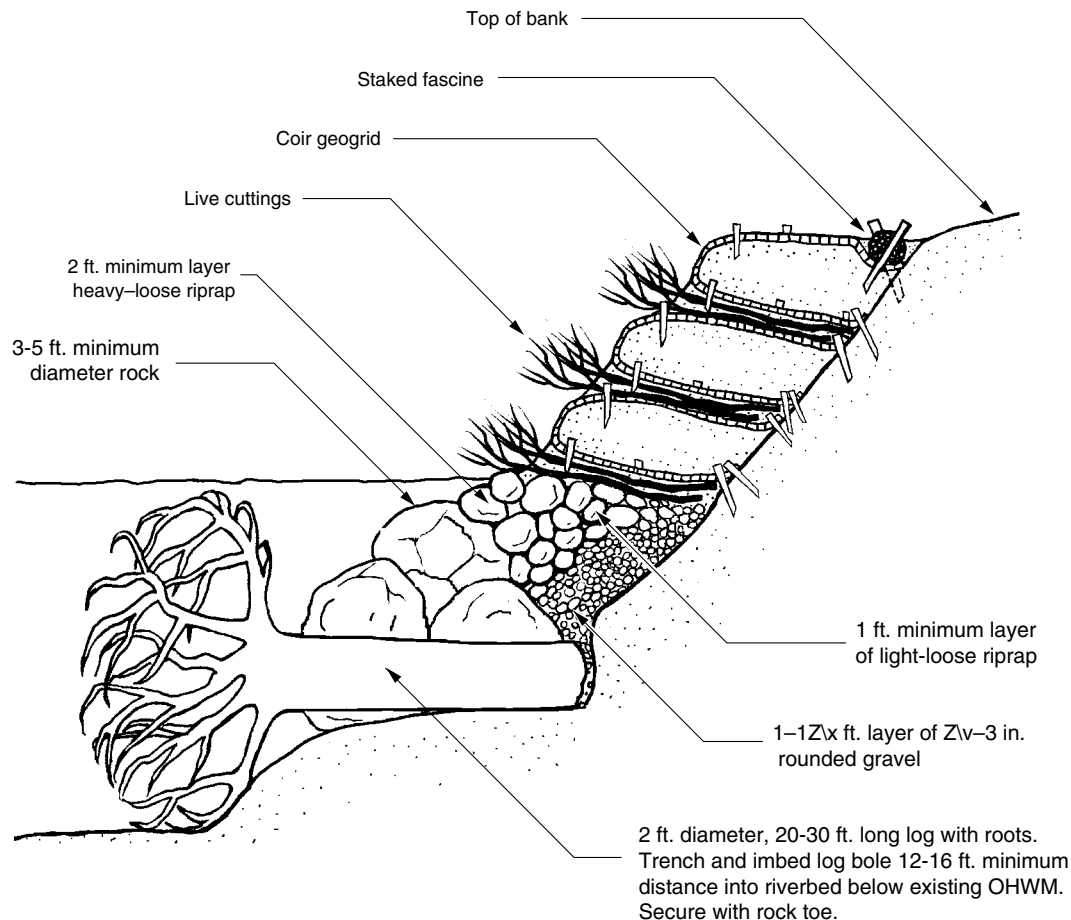
Prior to adoption of the FHRP, maintenance of King County flood control facilities consisted primarily of clearing riverbank vegetation and replacing riprap eroded by the river. This approach was costly, and because it often did not address the cause of the damage, had to be frequently repeated. The FHRP documented problems with these older methods and adopted a quite different approach that emphasizes much less environmentally damaging methods for bank stabilization and levee repair.

Since 1994, this preferred approach has represented the core of the Rivers new maintenance program – using bioengineering methods (soil biostabilization) such as brush layering to stabilize riverbank and levee slopes. A rock toe key is typically installed at the base of a facility, to minimize the potential for flood-flow undercutting, erosion, and sloughing of the face of the project (Figure 4).

#### ***Installation or Repair of Facility Rock Toe Key Using Large Rock and Anchored LWD***

At sites where toe erosion has been identified as the mode of bank failure, bank stabilization structures should be keyed into the channel bed at the bank toe. Similarly, all alluvial rivers and streams scour during flood events and unless the bed is naturally armored with large material, structures must be protected against undercutting. It is important that appropriately sized toe rock be placed deeper than the predicted riverbed scour depth (Johnson and Stypula 1993).

**FIGURE 7**  
***Integrated System Using Large Woody Debris***



While rock toe keys were not originally installed on many of King County's river levees and revetments, they are now included as an important element of many facility repairs and upgrades. Large rock is frequently used in the toe to stabilize the facility as well as to anchor pieces of large wood added to upgrade the habitat value of riverbank facilities (Figure 7). Rocks create habitat by providing refuge from high flow velocities (a form of cover) and creating scour holes. Large wood similarly increases both substrate and habitat diversity (Johnson and Stypula 1993).

#### ***Regrading and Set Back of Revetment/Levee Slopes to More Stable Gradients***

Many older river levee and revetment structures were initially built at too steep a gradient. Over the years, these structures have been subject to flood scour and slumping such that they are now unstable. Regrading these levee and revetment slopes to more stable gradients is often one element of an overall river facility repair or upgrade project. Where practicable, this regrading activity can include set back of an existing levee, to increase available flood storage volumes and overbank conveyance, thus reducing flood stages. When riparian plantings are added to the setback bench, additional habitat benefits can also be provided.

### ***Excavation of Revetment/Levee Mid-Slope Benches***

The rock toe key – so critical to increased bank stability – can be difficult to construct in rivers with high banks. In these situations, it is extremely difficult to reach down from the top of the bank or levee to key rock in at the toe of the slope. An alternative design is a mid-slope bench at or near ordinary high water that can be used as a construction platform. The bench can be left as a permanent feature that then allows the upper bank revetment to be set back from the main channel of the river. Once again, this provides the benefits of increased flood storage and overbank conveyance, while planting vegetation on the bench can add riparian habitat benefits.

### ***Reconstruction or Repair of Revetment/Levee Slopes Using Biotechnical Bank Stabilization Methods***

This new preferred approach to riverbank stabilization, using biotechnical methods, has already been outlined under the structural CIPs program element. Additional details of these approaches are presented in the King County [Guidelines for Bank Stabilization Projects](#) (Johnson and Stypula 1993).

Current maintenance practices emphasize the use of large woody debris, live native plant cuttings, and soil wraps, as structural and habitat elements. These biotechnical techniques have been applied to most River’s-sponsored levee and revetment maintenance, repair, and upgrade projects since 1991.

To illustrate implementation of a representative River Section levee/revetment repair and upgrade project, standard drawings for the proposed Desimone Levee Toe Repair on the Lower Green River are included as Appendix D. Note that the cover sheet summarizes temporary erosion and sediment control requirements as well as detailed construction sequencing, levee slope reconstruction, and proposed long-term monitoring. Sheet Two illustrates the levee set back completed in 1999, while Sheet Three shows the proposed rock toe key replacement, brush-layered bank stabilization, and proposed set-back bench and levee plantings. The final sheets list the native riparian plant materials to be installed.

## **3.4 Implementation**

The level of major maintenance activity varies from year to year. In the three years following the large floods of 1995 and 1996, several projects were completed each year. The disaster response mode dwindles as the most critical maintenance is completed and federal matching dollars disappear. In the standard non-disaster response mode, funds are limited and the program may average one or two maintenance projects total for all King County rivers, excluding the Green. The Green River Flood Control Zone District (GRFCZD) levy enables funding of two to three maintenance projects on the Green River annually. In a standard year across the County, this amounts to an average of 500 linear feet of repairs and expenditures of \$250,000. In a disaster-response year, an average of 4,500 linear feet of repairs with expenditures of \$1,700,000 to \$2,800,000 is completed.

Since adoption of the new FHRP policies and bank stabilization guidelines in late 1993, the River Management Program has completed 83 repairs and upgrades on various facilities

– mostly levees and revetments – throughout King County. The distribution of these projects among the County’s major river systems is summarized in Table 1-5 of Chapter 1.

Because required ESA reviews have postponed several River’s facilities maintenance projects planned across the County, recent performance levels have been reduced.

### ***Potential Conflicts***

The same potential conflicts between federal funding/regulatory agency design criteria minimizing vegetation associated with levees and revetments and King County’s promotion of biotechnical approaches to bank stabilization, noted above under structural CIPs, apply to River’s major maintenance activities.

## **(4) ROUTINE MAINTENANCE**

### **4.1 Program Element Goals**

This program element addresses the goal of “Routine Maintenance” at River’s facility sites. As noted above for major maintenance, the FHRP includes general guidance on maintenance activities but does not specifically define “Routine Maintenance.” Over time, this has come to include maintenance activities that do not involve major earth moving and thus do not require mobilization of heavy equipment. Since these activities rarely include in-channel disturbance or construction, they typically require less consultation with other agencies, and much less permitting.

Examples include: facility inventory and annual assessments; levee slope mowing; mowing for flood patrol access; access control and maintenance; control of invasive plant species; irrigation; vegetation replacement; and hazard tree removal. Two other activities included here would likely include in-channel work and are more controversial – logjam removal, and river channel dredging (i.e., more precisely, river bar gravel removal).

### **4.2 FHRP Supporting Policy**

Once again, General Policies G-6, 7, and 8, address the issues of reducing long-term public costs (i.e., emphasize low-maintenance solutions), protecting natural resources and functions of floodplains, wetlands, and riparian corridors (i.e., includes potential enhancement or restoration), and multi-objective management of water resources. Flood Hazard Reduction Project Policies identify general procedures for determining problem/project eligibility (Policy FHR-1), problem prioritization (Policy FHR-2), and the evaluation of project alternatives (Policy FHR-3).

While no specific policy guidance is offered on most routine maintenance activities, logjam removal and dredging are addressed under River Channel Maintenance Policies. Policies RCM-1 and 2, describe when and how large woody debris (LWD) should be removed from or relocated within rivers and streams. Logjams should only be disturbed if they pose a direct threat to properties eligible for protection under Policies FHR-1 and 2. If LWD

must be moved, it must be dislodged or removed and placed back into the river system at the next practical/reasonable or adjacent location.

Policy RCM-3 describes when and how dredging or gravel bar scalping of rivers, streams, and deltas could be performed for flood or erosion control purposes. Much like LWD, gravel should only be removed if it poses a direct threat to eligible properties and where its removal is determined to be the best flood damage reduction alternative available (again applying Policies FHR-1, 2, and 3).

### **4.3 Project Examples and Activities**

#### ***Facility Inventory and Annual Assessments***

The FHRP calls for the maintenance of a facility inventory to serve as “...*the beginning of an ongoing river modification plan...*” and routine facility assessments to help identify and prioritize maintenance needs. A facility inventory was created in 1992 but has only been sporadically maintained. Similarly, since the adoption of the FHRP (1993) annual damage assessments have been conducted mostly on an ad-hoc basis with little or no organized record keeping. The most recent comprehensive assessment was conducted following major floods in 1995 and 1996.

The River Management Program is currently re-evaluating its inventory and assessment procedures and has begun maintaining its inventory.

#### ***Levee Slope Mowing***

The most significant routine maintenance issue addressed in the FHRP is the conflict between levee maintenance standards advocated by King County, and maintenance standards established through the Federal assistance programs authorized under Public Law 84-99. Army Corps of Engineers (Corps) maintenance standards for levees generally call for the removal of all trees greater than four inches in diameter and all vegetation that interferes with visual inspection of the facilities. In contrast, FHRP Policy G-7 calls for the protection of the ecological value of riparian corridors, which is generally construed to include the preservation and promotion of native plant communities.

King County has attempted to maintain the eligibility of its levees for federal assistance programs and still meet the intent of FRHP Policy G-7 by limiting vegetation removal to blackberries and other invasive species. This approach has allowed several levees without significant trees or native underbrush to be maintained to Corps standards; however, over time, the number of eligible levees will decrease as trees and other non-invasive species take hold. This conflict between Corps standards and King County policy will become especially apparent if federal inspectors call for the removal of vegetation on levee sections previously repaired using bioengineered techniques and upper bank plantings.

#### ***Mowing for Flood Patrol Access***

While not discussed in the maintenance section of the FHRP, King County does periodically mow both levee and revetment access roads to allow crews to patrol these facilities during flood events. The preferred time for mowing is in the late fall, just before the winter flood season.

Mowing for compliance with Corps standards and for flood patrol access is not tracked separately. The combined Countywide mowing effort over the past few years has covered between 100,000 and 200,000 square yards per year.

### ***Access Control and Maintenance***

While not discussed in the maintenance section of the FHRP, King County does maintain access gates and gravel roads on most of its river facilities. These access roads are typically located at the highest elevation, along the top of levee prisms or revetments. Access road resurfacing is rare, and is usually accomplished in conjunction with a major maintenance project. In 1998, 800 lineal feet of access road was resurfaced as a stand-alone project on the Rainbow Bend levee on the Cedar River.

Gates that limit public access to river facilities are also occasionally repaired or replaced. Gates are painted prior to installation, so no painting activity occurs on-site. In recent years, about five gates have been replaced each year.

### ***Control of Invasive Plant Species***

To improve the success of biotechnical facility repairs, comply with state noxious weed regulations, and in some cases, meet specific permit requirements, King County removes invasive species from project repair sites and areas where listed noxious weeds are present. The non-native species most commonly encountered include blackberries (*Rubus sp.*), Japanese or giant knotweed (*Polygonum cuspidatum*), knapweed (*Centaurea sp.*), tansey (*Tanacetum vulgare*), and Scotch broom (*Cytisus scoparius*). In most cases, weeding has been accomplished through hand labor; cut stalks are frequently dabbed with appropriate herbicides immediately after cutting. All herbicide application is completed by a licensed technician in accordance with County adopted integrated pest management practices.

Currently 5000-10,000 square yards of invasive species are removed each year.

### ***Irrigation***

Irrigation is mentioned but not described or prescribed in the FHRP. To improve the success of bioengineered facility repairs, King County irrigates most projects weekly during late summer and early fall for two years after the completion of each project. A one or two person crew typically irrigates with a gasoline-powered pump to withdrawal water from the river. The pump intake is screened in accordance with Washington Department of Fish and Wildlife (WDFW) standards. All withdrawals are documented per a water withdrawal permit issued by the Washington State Department of Ecology (WDOE).

The summer of 1998 was a peak-watering season with 24 projects using a total of 276,350 gallon of water. Watering since been reduced as plants have become well established and fewer new projects have been constructed.

### ***Vegetation Replacement***

The FHRP calls for annual inspection, and where appropriate, replacement of vegetation planted at recent facility repair sites. This need for this maintenance is echoed in HPA and Grading Permit conditions. Revegetation is accomplished by hand crews and typically involves transplanting native species from one- or two-gallon containers. Revegetation needs are identified in late summer and planting occurs in the fall or winter.

In recent years several thousand plants have been planted to replace dead or stolen project site vegetation.

### ***Hazard Tree Removal***

The FHRP does not address hazard tree, or blow down removal. Trees, however, do occasionally fall across access roads or pose a threat to those using the roads. These trees are either removed entirely, or moved to the riverward side of the facility.

Countywide, fifteen trees were removed or relocated in 1999.

### ***Log Jam Removal***

FHRP policies and recommendations state that King County should include the evaluation of log jams in the annual assessments to determine whether specific jams should be removed or repositioned to eliminate immediate hazards to public property or private homes and businesses. FHRP policies state that if LWD must be removed, it should be put back into the river channel, or adjacent riparian corridor, at the nearest practicable location. In practice, the need to evaluate logjams typically arises during flood events when trees fall from eroding banks and previously deposited wood is re-mobilized.

Approximately 25 logjams have been investigated and documented – and several others have been visited but not documented – since 1990. Of these, five or six have been altered to reduce an immediate threat.

### ***Dredging***

The FHRP includes policies to identify dredging as a potential maintenance procedure to reduce flood hazards and calls for monitoring to assess potential dredging benefits. The Plan also discusses analyses that should be considered before undertaking a dredging project.

Since the adoption of the FHRP, King County has established monitoring cross sections at several locations and is in the process of completing a draft gravel-removal study for the Snoqualmie River. The term “gravel-removal,” which refers to out of water bar scalping, is considered a more appropriate approach to restoring conveyance than in-water “dredging.” The gravel removal study will provide information on the potential flood hazard reduction associated with different levels of gravel removal at different locations. These options will have to be considered in the context of anticipated revisions to the FHRP policies concerning “dredging”.

## **4.4 Implementation**

Several of the routine maintenance descriptions outlined above include River’s staff estimates of the annual level of effort for that particular activity. Present best available estimates for annual levels of routine maintenance carried out by the River’s Program are summarized in Table 1-6 of Chapter 1.

The primary constraints to timely completion of routine maintenance are financial and institutional. Politically, routine maintenance often receives little interest until its absence results in catastrophe. Similarly, establishing a detailed facility inventory and reliable maintenance tracking system are given low priority when the immediate problems caused by not having such systems in place are absent.

### ***Potential Conflicts***

To date, the principal conflict regarding routine maintenance – along with major maintenance and structural CIPs – is that regarding vegetation management as already noted above.

It is likely that ESA salmonid habitat concerns will also require re-examination of current FHRP policies regarding both logjam removal and gravel-removal/dredging.

## **(5) EMERGENCY RESPONSE**

### **5.1 Program Element Goals**

Many different agencies and jurisdictions play a role in responding to flood emergencies. The goal of this program element is to clearly establish King County's role relative to other jurisdictions during flood emergencies.

### **5.2 FHRP Supporting Policy**

The FHRP established two policies specifically addressing Emergency Response. Policy ER-1 identifies King County as the lead agency in managing and coordinating emergency public health, safety, and welfare services before, during, and after flood emergencies within the County. Policy ER-2 addresses sandbag distribution:

“King County should provide a limited supply of sand and sandbags for private property owners during flood emergencies. Citizens should be responsible for requesting, picking up, filling and placing sandbags, as well as cleaning up sandbags and sand on their property after floods. Sandbags should be placed as close as possible to the foundation of the structure being protected.”

### **5.3 Project Examples and Activities**

In 1993, when the FHRP was written, King County was already actively involved in flood fighting. Flood fighting involves taking physical measures to protect property and facilities that are directly threatened by flooding. Typical flood fighting tasks include sandbagging, dumping rock on river and stream banks to prevent bank erosion, and repairing levees to prevent catastrophic failure.

During major flooding, King County dispatches flood patrols to inspect levees, revetments and other County facilities. When a flood patrol discovers a debris jam threatening a critical County facility, or a facility needing urgent repair, a request is made to the County's Flood Warning Center for an engineer to determine repair needs. King County Roads Division crews typically carry out repairs.

The FRHP states that during a major flood disaster an engineer may be unavailable in a situation demanding an immediate response. Field crews therefore need some form of written instructions for performing emergency work. The FHRP recommends that King County develop emergency guidelines to direct flood patrols in the performance of urgent repairs when an engineer is unavailable to direct work.

Activities that may be necessary during a flood emergency are likely to include the following:

- Emergency Bank Erosion Repair
- Emergency Levee Repair
- Emergency Debris Jam Removal – see routine maintenance discussion
- Sandbag Distribution and Use

## **5.4 Implementation**

During major flood events, King County may carry out emergency response activities needed to prevent significant erosion and damage to eligible public facilities. At the time an emergency response is identified, calls are made to appropriate permitting agencies (US Army Corps of Engineers, Washington Fish and Wildlife Service, and County or City grading and shoreline agencies) to receive verbal approval.

A biological assessment and mitigation may subsequently be required as a condition of these emergency verbal permit approvals.

### ***Potential Conflicts***

It is likely that some emergency response activities – such as dumping rock to protect against bank erosion, or emergency levee repairs – could cause harm to existing riverbank habitat functions and values. Emergency placement of sandbags, or inappropriate cleanup activities, might also result in conflicts with existing habitat functions and values.

## **(6) COMPLAINT RESPONSE AND ENFORCEMENT**

### **6.1 Program Element Goals**

This Program element addresses two distinct but closely related goals: (a) responding to citizen complaints – some regarding Code violations, others concerning problems with County drainage or flood control facilities; (b) enforcement of County river and flood plain-related development regulations.

The FHRP notes that passage of the Sensitive Areas Ordinance (SAO) in 1990 gave King County some of the most stringent flood plain regulations in the United States – e.g., zero-rise floodway and compensatory storage requirements. The Plan further notes “...*having regulations ‘on-the-books’ does not ensure that they will be effective in the field. Without adequate enforcement, regulations may never be translated into reality.*”

## **6.2 FHRP Supporting Policy**

Several FHRP Policies clearly identify the stringent flood plain development restrictions referred to in this element’s goals: restrictions on new development in hazardous areas (Policies G-2 and 3); the need for intergovernmental cooperation and compliance with state consistency requirements (Policies G-10 through 13); and specific flood plain land use requirements (Policies FP-1 through 8). Information and education policies stress working with both the public and other jurisdictions to be sure that flood risks and development regulations are clearly understood (Policies E-1 and 2). None of these adopted FHRP Policies, however, directly addresses the issue of handling citizen complaints, or the enforcement of river and flood plain regulations.

It should be stressed that the processing of County Code violations is presently the responsibility of the King County Department of Development and Environmental Services (DDES); any Code violations that come to the attention of Rivers’ staff must be coordinated with DDES. Both WLR and DDES have enforcement authority over all water quality and drainage manual Code violations. Some violations are more appropriately passed along to the Washington Department of Fish and Wildlife.

## **6.3 Project Examples and Activities**

This Program element only identifies and tracks potential problems with rivers and flood facilities. Any recommendations that result in proposed projects are implemented under other Program elements.

The FHRP recognized that enforcement of flood plain regulations and other provisions of the County SAO is an enormous task, potentially requiring additional field and technical review staff. “Eyes and ears” are needed in the field to identify new violators, monitor past violators for environmental compliance, and to assist those that are out of compliance. The Plan recommended hiring “River Stewards” to fill this role and to respond to citizen complaints regarding river flooding and resource issues. While no designated river stewards have been hired to date, “Basin Stewards” in WLRD presently fill a similar role.

Rivers’ staff investigate complaints about flooding, channel migration, severe bank erosion and logjams on a year round basis, and especially during and immediately following flood events. During floods, two-person teams patrol flooded areas along the major rivers to provide rapid response to flooding complaints and evaluate whether there is an imminent threat to public safety and/or public facilities. Patrols also inspect County river facilities for structural damage and other warning signs that indicate potential facility failure that could adversely impact developed property and off channel habitat.

The nature of each complaint will generally form the basis for the scope of the investigation and subsequent action. Complaints in which the Rivers Section lacks the authority to pursue enforcement action in response to illegal activities and violations are typically referred to other agencies with enforcement capabilities, such as King County's Department of Development and Environmental Services or Washington Department of Fish and Wildlife. Complaints in which the Rivers Section has the ability to directly impact results become the focus of their efforts. These typically include analysis and problem solving to minimize bank erosion, flooding, and to address other flood plain issues.

## **6.4 Implementation**

Although Rivers uses specific data forms to log complaints received, they usually do not know the outcome once a complaint is forwarded to another jurisdiction. Due to lack of a formal process for tracking complaints and Code violations, the level of annual response and accomplishments cannot be precisely determined. Numerous complaints or citizen inquiries are received and investigated without a formal complaint investigation form ever being completed.

In 1999, several King County agencies contracted with a consultant to develop a GIS-based tracking system to log and track complaints. "Beta testing" of this software is currently underway, and once finalized should help support a more formal, standardized complaint process. This system is expected to track both "complaints" and general information requests and inquiries.

### ***Potential Conflicts***

No specific conflicts were identified for this Program element. While critically important, enforcement is often seen as an unpleasant and potentially contentious task that places an agency or program at odds with others. Enforcement of some river and flood plain regulations may also raise the specter of a debate concerning private property rights.

## **(7) MONITORING**

### **7.1 Program Element Goals**

The FHRP describes extensive monitoring needs under "Maintenance and Monitoring." Here the term "monitoring" is used primarily to describe the evaluation of the intended flood and erosion control function of river facilities. Related recommendations include evaluation of the effect of each facility on fish habitat; monitoring changes in channel cross-sections in leveed reaches and the hydraulic impacts of river facilities; a call for collection of "...*information about the river system before and after construction;*" and annual assessments of river facilities to identify flood damage and determine maintenance needs. (See also River Planning, Program element 8.)

Additional monitoring needs are inferred by reference to the "...*new standards developed in the Guidelines for Bank Stabilization.*" Monitoring standards in the Guidelines call for

annual determination of the “percent survival” of revegetation materials for at least three years after construction. The need to monitor invasive species, and for photo-documentation of overall facility conditions each fall and spring, are also indicated. Monitoring for fish use also occurs at some project sites in response to specific permit requirements.

## **7.2 FHRP Supporting Policy**

While the FHRP text discusses several issues related to monitoring, none of the 45 formally adopted FHRP Policies directly address this issue.

## **7.3 Project Examples and Activities**

This program element is solely concerned with monitoring the results or effects of various Rivers’ activities. These activities can include field studies in support of the following:

- Damage assessment following major floods (1990, 1995, 1996).
- Evaluation of intended flood and erosion control functions of each facility.
- Evaluation of effects of each facility on river hydraulics.
- Evaluation of effects of each facility on fish habitat.
- Monitoring of changes in channel cross-sections in leveed reaches to evaluate sedimentation and scour.
- Monitoring of percent survival of revegetation materials.
- Monitoring for invasive plant species.

While all of the types of monitoring listed above are mentioned or implied in either the FHRP or bank stabilization guidelines, few are described in detail. To date, the River Management Program has not developed a clearly defined, comprehensive, program-wide monitoring plan.

The clearest monitoring identified in the FHRP is for establishing channel cross sections to monitor sediment levels and to estimate ongoing rates of sediment accumulation or scour. Cross sections have been established and monitored along the lower Raging and Tolt Rivers, the South Fork Snoqualmie River, and portions of the mainstem Snoqualmie near Fall City and Carnation. Cross sections have also been established on the White River near Auburn and in selected locations on other rivers, including the Cedar and Green Rivers.

## **7.4 Implementation**

The monitoring activities described in the FHRP (hydraulic, channel cross-sections, photo-documentation and vegetation survival), have been implemented on an ad-hoc basis with little or no documentation. To date, the only comprehensive efforts have been damage assessment reports following major floods in 1995 and 1996. Facility-specific work has typically included pre- and post-construction photo-documentation (although not

necessarily at fixed photo points) and follow-up visits to qualitatively assess additional revegetation and weeding needs. Documentation of these visits and follow-up maintenance actions has improved with the 2000 and 2001 inspections. One repair site on the Green River (Hamakami) has been the subject of a multi-year, interdisciplinary monitoring effort (Jeanne Stypula, personal communication, March 2001).

The primary limitation on implementing the FHRP monitoring recommendations has been competition from other work program priorities and lack of assigned staff. A backlog of outstanding HPA and Grading permit conditions related to monitoring, and a desire to better understand the effectiveness of recent facility repairs, recently resulted in assignment of a Monitoring Program Lead to develop and implement a Project Monitoring Plan for the Rivers Section. This plan, which is currently under development, will include among its objectives: (a) the fulfillment of outstanding monitoring obligations; (b) development and implementation of monitoring plans for future projects; and (c) evaluation of selected technical questions that could improve future projects. The proposed monitoring program will include a greater emphasis on biological mitigation elements than is currently described in the FHRP.

### ***Potential Conflicts***

No specific conflicts were identified for this Program element. It is likely, however, that the various state and federal natural resources regulatory agencies will play a significant role in defining appropriate River's Program monitoring requirements.

## **(8) RIVER PLANNING**

### **8.1 Program Element Goals**

The goals of this Program element include a broad range of studies, plans and hazard mapping for use in River Management Program project selection and design, and flood plain land-use regulation.

The 1993 FHRP calls for new hydrologic and hydraulic models to be completed to more accurately estimate predicted flood flows and flood hazard areas. Complementing the development of new water surface elevations and extent of inundation is the delineation of channel migration areas, which illustrate potential lateral movement of an active river channel. Sediment transport studies are recommended to provide the information necessary to evaluate dredging or bar scalping as means of flood hazard reduction.

The FHRP also identifies the need for fish habitat studies and recommends that existing and potential salmonid habitat areas be identified through detailed studies in each of the major river basins. The intended use of fish habitat studies was to improve the implementation of structural CIPs by reducing impacts and providing habitat enhancement benefits.

River greenways, providing multiple beneficial uses, can create wide, open floodplain areas that maximize flood storage and conveyance. The FHRP recommends that plans for

greenways be developed for all County river corridors and identify opportunities to enhance fish and wildlife habitat, improve recreational opportunities, and reduce flood and erosion damages.

The FHRP identifies multi-objective dam operations studies as another component of river planning. These studies would examine the potential to modify dams operationally or physically to reduce flood-related property damage, while at the same time protecting fisheries and recreational opportunities.

## **8.2 FHRP Supporting Policy**

Numerous of the FRHP Policies relate either directly or indirectly to the need for river planning studies. General Policies G-2 and 3, restricting new development in hazardous areas, imply that such areas are accurately identified and mapped. Policy G-7, requiring protection of flood storage and conveyance, together with protection of natural resources, similarly implies accurate knowledge of these functions. Policies G-9 through 13, all address aspects of planning with a watershed perspective, intergovernmental cooperation, and in compliance with state consistency requirements. Several additional policies address flood plain land use (Policies FP-1 through 8) and watershed management (Policies WM-1 through 4) issues. Flood Hazard Reduction Policy FHR-8, stresses the need for multi-objective flood hazard reduction planning. Included within these policies are direct requests for, or the implied needs for, all of the types of river planning studies listed below.

## **8.3 Project Examples and Activities**

**No Construction Projects** – This program element is solely concerned with planning activities. These activities can include field studies in support of the following:

- Flood plain modeling and mapping.
- Channel migration studies and mapping.
- Sediment transport studies.
- Fish habitat studies.
- River greenway plans.
- Dam operation studies.
- Levee failure damage potential evaluations.

## **8.4 Implementation**

Since 1993, new flood hazard mapping using FEMA guidelines has been completed for portions of the Tolt, Raging, North-Middle-South Forks of the Snoqualmie Rivers and the South Fork of the Skykomish River. New mapping for the Cedar River is now in progress. There is a one to two year timeline for FEMA review and approval of flood plain map revisions.

Channel migration mapping has been completed for the Tolt, Raging, and Middle Green Rivers, and the Three Forks area of the Snoqualmie River. The FHRP-recommended public rule to adopt administrative procedures for regulating “channel migration zones” has taken nearly seven years to be finalized – even though these areas have been regulated since FHRP adoption in 1993. Continued work on mapping the Cedar River migration zones is dependent on approval of funding.

Basin scale fish habitat studies have not been undertaken by the Rivers Section as similar work is already the responsibility of others. Since the ESA listings of Chinook and bull trout, these types of studies are mainly being planned and undertaken by the Watershed Coordination Unit and the Modeling, Monitoring and Assessment Section of WRLD. Rivers staff may participate in broader studies as they relate to project specific needs for baseline information and monitoring activities.

A study of sediment accumulations is nearly complete for the three reaches of the Snoqualmie River basin: the Tolt River and the adjacent mainstem reach of the Snoqualmie River, the Raging River and the adjacent mainstem reach of the Snoqualmie River, and the South Fork Snoqualmie River. This study characterizes present sediment accumulation and flooding conditions, and evaluates the potential effectiveness of gravel removal for flood reduction in each study reach. Preparation of this gravel study has been coordinated with resource agencies and stakeholder groups.

The recommendation to develop River greenway plans has not been extensively implemented to date. The Sammamish River Conditions and Opportunities Report (December 1993) is the only plan of this type to be completed.

Different governing branches of King County presently address the issues of flood protection, recreation, and habitat – largely through separate planning and implementation programs. Coordination of these plans and programs continues to improve. A proposed pilot program would bring together interested parties to develop a Sammamish River Greenway, to refine the multi-objective recommendations, to establish project prioritization mechanisms, and to implement a watershed-scale program.

King County does not operate any dams itself. Of the four dams in King County, two are operated by the City of Seattle for water supply (S.F. Tolt and Cedar Rivers) and two are operated by the Corps for flood control (Green and White Rivers). In addition, the City of Tacoma has a water supply diversion from the Green River and the City of Seattle provides some hydroelectric power on the Cedar River. King County helped the Corps of Engineers develop a flood-forecasting model for the Green River downstream of Howard Hanson Dam. The County also cost shared with the City of Seattle and City of Renton on studies of the Masonry Dam on the Cedar River (Masonry Dam Flood operations Study, NW Hydraulic Consultants 1997). These studies conclude that dam operations could better optimize the competing goals of water supply, power production, flood control, and fish habitat protection.

### ***Potential Conflicts***

No specific conflicts were identified for this Program element. It is noted however, that when program planning activities move from a single focus (e.g., flood hazard reduction) to achieving multiple benefits (e.g., hazard reduction, habitat enhancement, and recreational opportunities), the number of stake-holders, the complexity of the planning process, and the time involved to achieve consensus, all increase geometrically.

## **(9) FLOOD HAZARD EDUCATION**

### **9.1 Program Element Goals**

The goal of this Program element is to educate the public about river safety and flood hazard issues. The 1993 FHRP recommended greater public education to enhance the public's awareness of flooding hazards throughout King County. The recommendations suggested production of a new comprehensive flood hazard informational brochure; expanded "Flood Awareness Month" activities; and adoption of a King County Council ordinance that would require flood hazard disclosure by property owners and real estate agents involved in the sale of flood-prone properties.

### **9.2 FHRP Supporting Policy**

The FHRP includes two policies that specifically address the need for greater Public awareness of flood hazards across all King County jurisdictions. Policy E-1 indicates that King County should make available the following information to "*current and prospective residents and landowners in flood hazard areas:*"

- Known flood risks to their property and safety.
- Steps they can take to protect themselves and their belongings from flooding.
- Regulations affecting flood plain development activities.
- Types of disaster assistance available.

Policy E-2 indicates King County may provide technical assistance to other jurisdictions within the major river basins, to help develop and adopt flood plain policies, regulations, and standards that are consistent with its own. This would presumably also contribute to greater public awareness of flood hazard issues.

### **9.3 Project Examples and Activities**

**No Construction Projects** – This program element is solely concerned with educating the public about river safety and flood hazard issues.

Media used to disseminate flood hazard information include: (a) a comprehensive flood warning brochure; (b) a flood warning web site; (c) an annual Flood Awareness Month and associated activities; (d) a staffed Flood Warning Center during flooding events; (e) target mailings to repetitive loss properties; (f) flood plain and channel migration mapping

studies; and (g) direct flood plain inquiries by citizens. Information about King County's home relocation and buyout program (Program element 2.0) is also distributed through these flood hazard education programs.

The Rivers Section is also actively involved with providing education material to recreational river users about King County rivers and general boating safety. This outreach is accomplished through: (a) placement of ten interpretive signs at popular boat launch sites; (b) development and distribution of over 4,000 informational brochures; and (c) development of a web site. Additionally, River's project managers engage with an ad hoc Boating Safety Advisory Committee to provide a forum for discussing and receiving input on safety issues related to the installation of large woody debris in bank stabilization and restoration projects.

## **9.4 Implementation**

King County's education successes are well documented and reflected in its Community Rating System class level. The primary limitations to further implementing these policies reflect the natural limits on any public education program.

## **(10) FLOOD WARNING SYSTEM**

### **10.1 Program Element Goals**

The goal of this element is to maximize the effectiveness of King County's flood warning system. King County has operated a flood warning system since 1959. The purpose of the King County Flood Warning Service is to warn residents and agencies of impending floodwaters on major rivers so they can take action and prepare themselves before serious flooding occurs. In most locations, the warning system provides at least two hours advance notice before floodwaters reach damaging levels.

### **10.2 FHRP Supporting Policy**

The FHRP Policies that support development and refinement of King County's flood warning system are the same as those listed for flood warning and education (Element 9), and emergency response (Element 5).

### **10.3 Project Examples and Activities**

**No Construction Projects** – This program element is solely concerned with warning King County management agencies, riverside residents, and the general public of impending floodwaters on major rivers so they can take action and prepare themselves before serious flooding occurs.

When floods are imminent, King County activates its Flood Warning Center. Operation of the Center is based on a four-phase warning system, issued independently for each river. The thresholds for each phase are based on river gages that measure the flood flow and stage (flood depth) of the major rivers in various locations. King County staff monitor the gages on a 24-hour basis, so that actions can be taken depending on river conditions.

At Phase I, County personnel are put on alert and preparations are made to open the Flood Warning Center. When a Phase II threshold is reached, the Flood Warning Center is opened. Staff at the Center monitor river gages and flood conditions around the clock; gage information is updated hourly on a recorded message. When a Phase III threshold is reached, flood investigation crews are dispatched to monitor flood protection facilities such as levees. Phase II-IV warnings are issued to police, fire departments, schools, other agencies, and the public through news media and in some neighborhoods through volunteer phone lines.

During a flood, King County works closely with the National Weather Service to obtain forecast information used to make flood predictions. Close coordination occurs with the K.C. Office of Emergency Management, K.C. Roads, and other agencies to obtain up-to-date information about major flood problems, road closures, evacuations and other emergency services. Coordination also occurs with the U.S. Army Corps of Engineers and Seattle Public Utilities regarding dam operations. Personnel at the Center are available to answer questions and help interpret gage readings during a flood event.

## **10.4 Implementation**

The 1993 FHRP included 10 recommendations to enhance King County's flood warning system; eight of these have been successfully implemented.

The recommendation to map and model all major County river flood plains using continuous hydrologic models has not been implemented to date. The use of such hydrological models would increase the accuracy of flood forecasting.

To date, the recommendation to set up a network of neighborhood flood wardens in populated flood plain areas has not proved practical.

### ***Potential Conflicts***

No conflicts have been identified for this Program element.

## **(11) INTERAGENCY AND INTERLOCAL COORDINATION**

### **11.1 Program Element Goals**

All of the major river basins in King County include incorporated cities, many of which are located in flood plains. King County also shares jurisdiction in the White River with Pierce County, and in the Snoqualmie and Skykomish River basins with Snohomish County. Inter-local coordination with other cities and counties – a key goal of this element – is

therefore essential for successful implementation of the FHRP. Coordination with state and federal natural resources and regulatory permitting agencies is also critical the success of the River's program.

## **11.2 FHRP Supporting Policy**

Washington State's Growth Management Act requires that development regulations for critical areas and comprehensive plans be coordinated and consistent with the regulations and plans of other Counties and Cities that share borders or related regional issues. Consistency amongst flood plain regulations is also required by the Flood Bill (RCW 86.12). Consistency is defined in the plan as having regulations that do not pass along flooding, erosion, or resource impacts, outside the jurisdiction. Therefore, the FHRP provides six policies regarding cooperation and consistency: General Policies G-10 through 13, FHR Policy FHR-10, and Educational (technical assistance) Policy E-2.

## **11.3 Project Examples and Activities**

**No Construction Projects** – This program element is solely concerned with enhancing coordination among those counties, cities, and other regulatory jurisdictions, that share various overlapping responsibilities for all aspects of flood control across King County's river basins.

The FHRP recommended that King County provide technical assistance to cities sharing floodplain areas of King County. This assistance would include:

- helping city staff draft and review flood hazard regulations and floodplain management policies for consistency;
- providing County staff to brief city officials and answer questions about the impact of new regulations or policies;
- evaluating alternatives for jointly developing and funding floodplain management programs; and,
- provide mapping services on a cost-shared basis within incorporated areas where the adoption of new regulations or programs requires mapping that the County has already proposed in unincorporated areas.

The plan recommended that coordination be improved through inter-local agreements where appropriate.

## **11.4 Implementation**

Except for the lower Green River valley, inter-local coordination with other cities with shared flood plains has been occurring on an as-needed basis since adoption of the 1993 FHRP. Within the lower Green River valley, inter-local coordination agreements date back to 1978. When requested, King County provides technical assistance to cities, including

assisting in reviewing large development proposals in the flood plain. The County has cost-sharing agreements with the Cities of North Bend and Snoqualmie for 205 Corps-sponsored projects in those cities.

King County also coordinates with cities, first response agencies, school districts, and other local, state and federal agencies as part of its flood warning program (see Element 10) and after flood disasters. Coordination with federal and state agencies is also required to obtain agency grants.

#### ***Potential Conflicts***

No specific conflicts were identified for this Program element.

### ***FHRP CONSTRUCTION AND MAINTENANCE ACTIVITIES***

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To determine the potential impacts of River Management Program construction and maintenance activities on rare and endangered species, it is necessary to understand:

- (1) How and when individual projects are built or maintained;
- (2) What types of equipment and materials are used;
- (3) What construction or maintenance activities occur and how they are typically sequenced;
- (4) When and what kinds of precautionary or protective measures are taken at each project site;
- (5) At what time of year and under what circumstances a particular maintenance activity or construction project will be undertaken; and
- (6) How long it will take to implement or complete.

Despite the wide range of activities included within the various River Management Program elements described above, the majority of River's construction and maintenance responsibilities relate to riverbank levees and revetments. Program activities since adoption of the 1993 FHRP have continued to emphasize levee and revetment repairs and upgrades. They now, however, use the more innovative biotechnical construction methods adopted in the "Guidelines for Bank Stabilization Projects in the Riverine Environments of King County" (Johnson and Stypula, 1993).

For the purposes of this biological effects analysis, River's Program construction and maintenance activities can be arranged along a continuum of increasing potential temporary and long-term impacts to instream and riparian habitats and salmonid populations. At one end of the continuum are projects that can be constructed entirely outside the river channel and its associated 100-year floodplain. Next are levee upgrades within the 100-year floodplain that avoid any in-channel construction. In-channel construction projects might be limited to biotechnical repair and replanting of a riverbank levee, or an upper-riverbank stabilization project, with all work occurring above the ordinary high water mark. At the end of the continuum are projects that use a rock toe key installed below ordinary high water to anchor the project; installation of LWD; involve complete riverbank stabilization (commonly using "brush layering," alternating layers of willow cuttings and soil above

the rock toe); and installation, retrofit, or repair of full 100-year flood containment riverbank levees. Site preparation and staging, materials and equipment used, construction methods, and installation sequencing for many of these different projects are actually quite similar (see example, Appendix D).